Approved For Release 2001/05/11 : CIA-RDP78B04747A001700010005-8

8 March 1965

Dear Robin:

Enclosed you will find three copies of the reworked Final Report from [redacted] on their Phase II Trial #1. From the sound of their last letter which you and I received, it sounds like they expect some worthwhile results from their forthcoming second trial.

The following pages cover an explanation of the overlapping exit pupils. I hope that this will clear up the matter. The complexity of this method, along with 676 overlapped areas, all of which require calculation as shown, indicates that individual grating measurements are not practical. We could insert the gratings into the viewer and make measurements in the exit pupil plane with a photomultiplier tube if actual data was required. I have been planning then to ask [redacted] to just make individual measurements in their normal manner. Any comments from you and Dick along these lines would be considered.

STATOTHR

STATOTHR

Everything seems to be going fine. We are looking forward to the grating from Dick and your visit out here in May.

Sincerely,

STATOTHR [redacted]

Enclosures

Declass Review by NIMA/DOD

Approved For Release 2001/05/11 : CIA-RDP78B04747A001700010005-8

Approved For Release 2001/05/11 : CIA-RDP78B04747A001700010005-8

Explanation of Formula in Section 3.1.4 and Transmission Value in Section 3.1.6

The accompanying drawing shows the four-way overlap which occurs in the exit pupil plane. If the exit pupils were small, no overlap would exist; there would be an exit pupil matrix of 727 exit pupils. With the lens aperture size, optical distances and angular deviations of the grating, these overlap to produce 676 overlapped squares, each made up of four exit pupils as shown in the drawing.

In the simple case, Trial #1 (see Figure 1), the intensity of any of the 169 pupils were the function of the transmission in an order times any other order, such as 3% x 3% = .09%, or 4% x 5% = .20%. Then .2% x 169 would mean that 34% of the light flux is contained in the 13 x 13 exit pupil plane if all pupils had this combination.

I this case it becomes more involved. When the gratings are crossed each of the 727 exit pupils are made up in the same way that the other 169 orders were. When they are overlapped, the light flux in four of these pupil units are added to provide the total flux in this .142 x .142 area.

The total flux is now a summation of the following (see Figure 2):

	Y		X
Say pupil A is order	+4	x	+8
then pupil B is order	+4	x	+9
and pupil C is order	+3	x	+8
and pupil D is order	+3	x	+9

Also, only 1/4 of the flux in any pupil is used to make up this overlapped area (x).

$$\text{Then total flux} = \frac{A}{4} + \frac{B}{4} + \frac{C}{4} + \frac{D}{4}$$

$$= \frac{4 \times 8}{4} + \frac{4 \times 9}{4} + \frac{3 \times 8}{4} + \frac{3 \times 9}{4}$$

$$= \tfrac{1}{4} \Big((4 \times 8) + (4 \times 9) + (3 \times 8) + (3 \times 9)\Big)$$

The transmission is referred to the total flux without a grating, and therefore shows the relative intensity of the pupil units.

The general equation may then be written as

$$T_T = \tfrac{1}{4} (T_a \times T_b) + (T_a \times T_d) + (T_c \times T_b) + (T_c \times T_d)$$

Approved For Release 2001/05/11 : CIA-RDP78B04747A001700010005-8

Approved For Release 2001/05/11 : CIA-RDP78B04747A001700010005-8

T_T = total transmission of .142 x .142 overlapped exit pupil unit. Since transmissions are added (because the overlap occurs in the exit pupil plane), this total transmission is a relative figure showing what per cent of the total light flux falling on the grating is contained in this small square.

T_a, T_b, T_c, and T_d are individual orders such as 3 + 4 in the Y plane and 8 + 9 in the X plane.

The equation submitted before was wrong as a general equation. It is valid only where the X and Y orders are the same; that is, when a point is selected at, say, X and Y, 0 and 1, then

$$T_T = \frac{1}{4} (T_a \times T_b) + (T_a \times T_a) + (T_b \times T_b) + (T_a \times T_b)$$

$$= \frac{2(T_a \times T_b) + (T_a)^2 + (T_b)^2}{4}$$

(see previously submitted sheet for drawing)

Before when 3% was allowed in a single order as a minimum, a .09% would exist where this order overlapped itself. If the entire exit pupil was made up of these units 15.2% of the energy would be in the combined matrix (.09 x .169). Now when 676 overlapped units exist and the same minimum is allowed, it can be looked upon in the same way, i.e. 15.2% divided by the 676 units gives .0225% for each of the 676 units. The result of the previous equation T_T should always exceed .0225% to be above this allowable limit.

A 4:1 brightness difference could mean that T_T would vary from .0225% to .1%. An example is listed below.

The overlapped pupil is made up of order 3 + 4 in the Y direction and 7 + 8 in the X plane. Their individual transmissions are

Order	Transmission %	Plane
3	3	Y
4	4	Y
7	5	X
8	6	X

Approved For Release 2001/05/11 : CIA-RDP78B04747A001700010005-8

Approved For Release 2001/05/11 : CIA-RDP78B04747A001700010005-8

Then $T_T = \frac{1}{4} \; (.03 \times .05) + (.04 \times .05) + (.03 \times .06) + (.04 \times .06)$

$$T_T = \frac{1}{4} \; .0015 + .0020 + .0018 + .0024$$

$$T_T = \frac{.0077}{4} = .0019 = .19\%$$

Then 0.19% of total flux falls in this .142 x .142 area in the exit pupil plane.

Approved For Release 2001/05/11 : CIA-RDP78B04747A001700010005-8

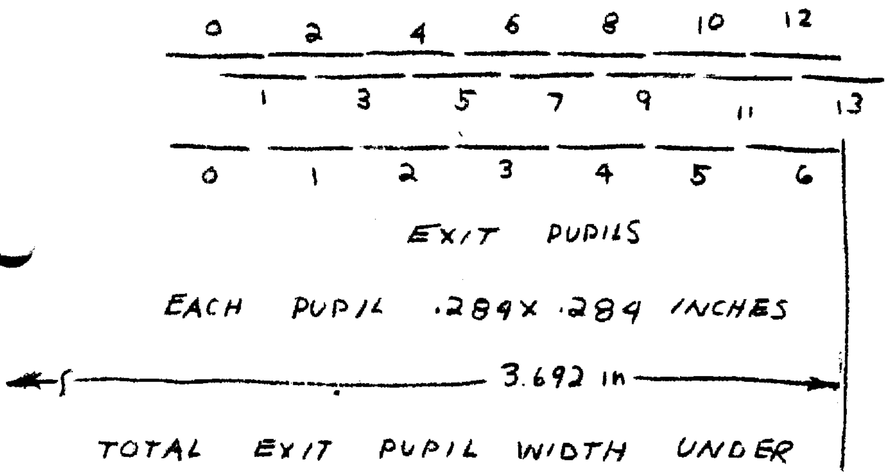
Approved For Release 2001/05/11 : CIA-RDP78B04747A001700010005-8

BY .... SHEET NO. .... OF ....

CHKD. BY .... DATE .... RELATIONSHIP OF COMBINED EXIT PUPILS JOB NO. 7506

[redacted]

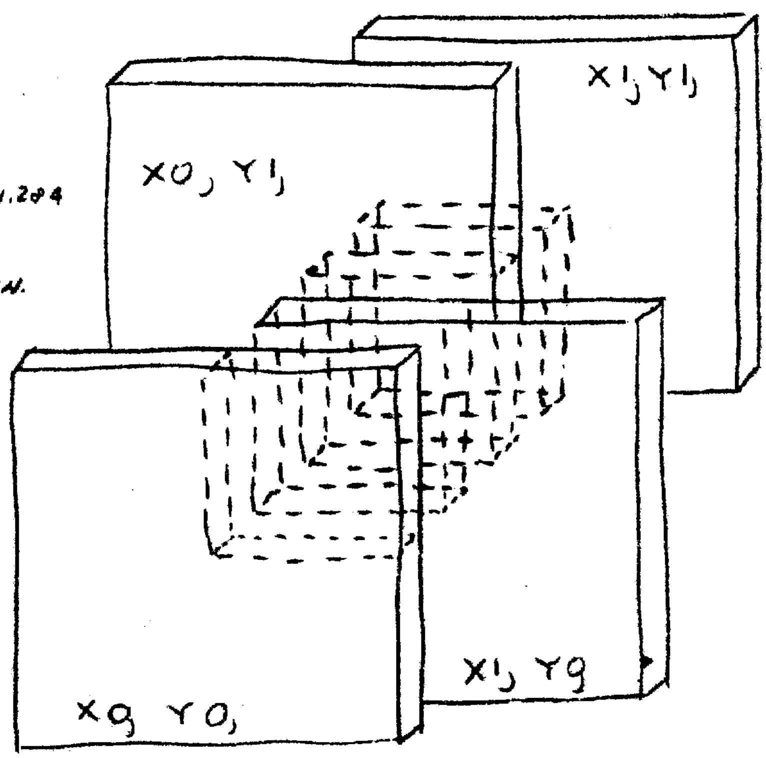
STATOTHR



TOTAL EXIT PUPIL WIDTH UNDER CONTROL OF SPECIFICATION

EXIT PUPIL .284 x .284
OVER LAP AREA
.142 X .142 IN.

FOUR EXIT PUPIL OVER LAP TO FORM ONE COMBINED ELEMENT



TYPICAL EXIT PUPIL OVERLAP

0 – 13 ORDERS

X →

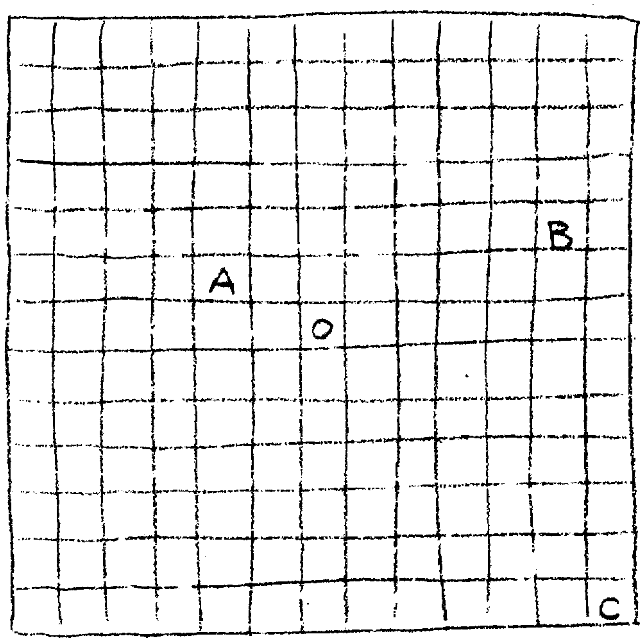
Approved For Release 2001/05/11 : CIA-RDP78B04747A001700010005-8

Approved For Release 2001/05/11 : CIA-RDP78B04747A001700010005-8

BY .... DATE .... SUBJECT: EXIT PUPIL RELATION SHIPS .... SHEET NO. .... OF ....

CHKD. BY [redacted] DATE .... JOB NO. ....

STATOTHR



ORDER COMBINATION	ORDERS X	Y
A	-2	1
B	5	2
C	13	-13

FIGURE 1

TRIAL 1 AND DICKS GRATING

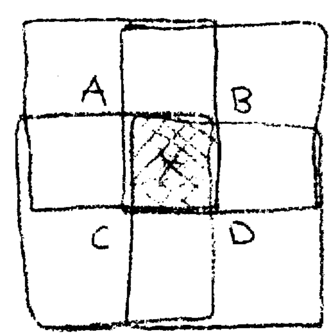


FIGURE 2.

Approved For Release 2001/05/11 : CIA-RDP78B04747A001700010005-8

STATOTHR Approved For Release 2001/05/11 : CIA-RDP78B04747A001700010005-8

[redacted]

STATOTHR

February 22, 1965

[redacted]

Dear Robin:

STATOTHR

Here is the calculated data on the "half-order" grating which we will be sending to [redacted] As before the wavelengths plotted are 500, 510, 520, 530, 540 and 440 millimicrons.

In order to evaluate the effect of the averaging I have added the calculated intensities of the zero and first order, then the first and second, then the second and third, etc. up to the twelfth and thirteenth for each wavelength.

I have also weighted each calculated intensity with the luminosity function and a tungsten light source and shown the result integrated over the 500-550 range. In this calculation the minimum order is only 64.4% of the maximum, and the maximum intensity ratio between adjacent orders is 1.48. All of which is quite promising.

STATOTHR

Thanks for getting [redacted] to join us and I will look forward to a demonstration of success in May.

Sincerely yours,

[redacted]

STATOTHR

Director
Optics & Contracts
RESEARCH & DEVELOPMENT

STATOTHR

[redacted]

spectral measurements on single;
convert to crossed grating
circumstance
crossing multiplies weaknesses

Approved For Release 2001/05/11 : CIA-RDP78B04747A001700010005-8

ILLEGIB

Approved For Release 2001/05/11 : CIA-RDP78B04747A001700010005-8

Next 2 Page(s) In Document Exempt

Approved For Release 2001/05/11 : CIA-RDP78B04747A001700010005-8